Relation Analysis between Learning Activities on Digital Learning System and Seating Area in Classrooms

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ABSTRACT
This paper discusses a relation analytics between learning activities and seating area in classrooms. Learning activities are collected via digital learning systems; including a learning management system, an e-portfolio system and an e-Book system. The activities are converted into barometers which indicate the amount of activities such as quiz scores, report scores, action frequencies on e-Books, length of journals, etc. The classroom is divided into 12 subareas, and the correspondence between students and the areas are also collected via the learning management system. We applied classical statistical analyses to the collected data. Through the experiments with about 200 students over 14 weeks, we found out that the seating area has strong relationship to learning activities.

Keywords
Learning activities, seating position, classroom

1. INTRODUCTION
Much attention has been paid to learning analytics (LA) and educational data mining (EDM) in recent years, since information and communications technology-based (ICT-based) educational systems have become widespread. Utilizing LA enables us to record various kinds of learning logs. Understanding students' behavior is a crucial issue in LA and EDM research domains. Therefore, there are many studies related to learning behavior analyses, such as behavior clustering[8], learning behavior in programming courses[1], preview and review pattern analyses[4], and academic performance prediction[3]. These studies commonly focus on learning activities corresponding to educational systems (activities in the digital world); they typically do not give much attention to activities in the physical world.

In this study, we focused on face-to-face lectures in which educational systems were introduced, and we analyzed how student seating areas correlated with learning activities recorded in the systems. There are a few related studies discussing the relationship between seating positions and behavior, such as the relationship between seat selection and academic achievement in small classes (less than 35 students)[6], seat location and an analysis of relevant comments from 55 students[7].

In contrast, the focus of our study was a larger scale classroom than in the abovementioned studies. More than 200 students attended the lecture, and the learning activities and student seating areas were examined over 14 weeks. To the best of our knowledge, this is the first study handling a large number of learning activity logs for the relational analysis between learning behavior and seat selections.

2. DIGITAL LEARNING PLATFORM
2.1 M2B system
At Kyushu University in Japan, a digital learning platform, the M2B system, was introduced in 2014. The M2B system consists of three subsystems; a learning management system (Moodle), an e-portfolio system (Mahara), and an e-book system (BookRoll). BookRoll is a self-developed e-book system for providing digital lecture materials and collecting browsing logs.

Various kinds of educational/learning logs are collected by M2B systems. Students submit their reports, answer quizzes, access materials, and reflect on their learning activities using these systems. More precise learning logs are collected by e-book systems (e.g., when a student opens an educational material or when he/she turns a page of the material).

Table 1: Calculation of active learner points (ALPs).

activity	point					
	5	4	3	2	1	0
quiz	Above 80%	Above 60%	Above 40%	Above 20%	Above 10%	Otherwise
report	Submission		Late			Not
login	Upper 10%	Upper 20%	Upper 30%	Upper 40%	Upper 50%	Otherwise
highlight	Upper 10%	Upper 20%	Upper 30%	Upper 40%	Upper 50%	Otherwise
memo	Upper 10%	Upper 20%	Upper 30%	Upper 40%	Upper 50%	Otherwise
action	Upper 10%	Upper 20%	Upper 30%	Upper 40%	Upper 50%	Otherwise
browse	Upper 10%	Upper 20%	Upper 30%	Upper 40%	Upper 50%	Otherwise
diary	Upper 10%	Upper 20%	Upper 30%	Upper 40%	Upper 50%	Otherwise

Table 2: Calculation of activity score during class

activity	point					
	5	4	3	2	1	0
ic_event	Upper 10%	Upper 20%	Upper 30%	Upper 40%	Upper 50%	Otherwise
ic_bookmark	Upper 10%	Upper 20%	Upper 30%	Upper 40%	Upper 50%	Otherwise
ic_highlight	Upper 10%	Upper 20%	Upper 30%	Upper 40%	Upper 50%	Otherwise
ic_memo	Upper 10%	Upper 20%	Upper 30%	Upper 40%	Upper 50%	Otherwise

2.2 Collection of Seating Area

Although the Moodle system has a plug-in that manages attendance of students, it cannot record seat positions. Another possibility is a student attendance system based on face detection[2]. However, the face detection technique is not perfect, so correct seat positions cannot be identified. Therefore, we developed a clicker system as a plug-in for the Moodle. Usually, the clicker is used for collecting answers from students. In our study, we utilized the clicker plug-in to collect information on the seating areas in the classroom. At the beginning of the weekly class, a teacher asked students to identify their seating areas by clicking the corresponding area number. As shown in Fig. 1, the classroom has about 240 seats, and the area is divided into 12 subareas.

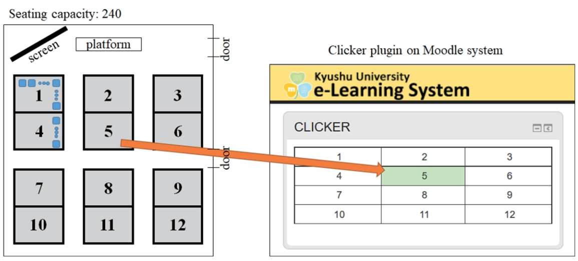

Figure 1: Left: top view of the classroom. About 240 seats are available in the classroom. The classroom is divided into 12 areas to collect the seating area of students. Right: clicker plugin on Moodle system. Students answer their seat area by clicking the corresponding area number.

2.3 Active Learner Point: ALP

We utilized Active Learner Points (ALPs) as barometers of learning activities calculated from various kinds of logs stored in the M2B system. In this study, we utilized three activities (quizzes, reports, and logins), four activities (highlight, memo, action, and browse), and an activity involving diary length from the Moodle system, e-book system, and Mahara system, respectively. Each activity was evaluated by the students using a conversion to a 5-level scoring system, as summarized in Table 1. Please refer to the literature[5] for a more detailed explanation about ALPs.

2.4 Learning Activities during On-site Class

The abovementioned ALPs mainly reflect students' out-of-class activities, such as previewing and reviewing. To analyze activities taking place in on-site classes, we introduced new scores calculated from e-book operation logs. The calculation of scores was inspired by the ALP, as shown in Table 2. To distinguish the scores from those of ALPs, we used the word "ic_" to indicate "in-class" activities. The score reflects the frequency of usage in each operation: how many times a student operates the e-book (ic_event), how often a student uses the bookmark operation, and students' usage of highlight and memo functions (ic_bookmark, ic_highlight, and ic_memo, respectively).

3. DATASET

We collected learning activity logs (in fact, more than 890,000 records in the database) over 14 weeks from a course in information science conducted at our university. This course is designed to provide an introduction to ICT technology in a number of disciplines. The course consists of a series of sessions on the major research areas of this technology, including an initial discussion of the conceptual foundations of algorithms, image processing, and character recognition.

About 200 students attended the classes every week. Data regarding learning activities during classes (i.e., in-class activities) and activities outside of class, such as the preview/review of materials, were collected through the M2B system. At the beginning of each class, the students identified their seating positions using the clicker plug-in. During a 90-minute lecture, the students opened the e-book and followed the explanation therein while creating bookmarks, highlighting texts, and creating memos as necessary.

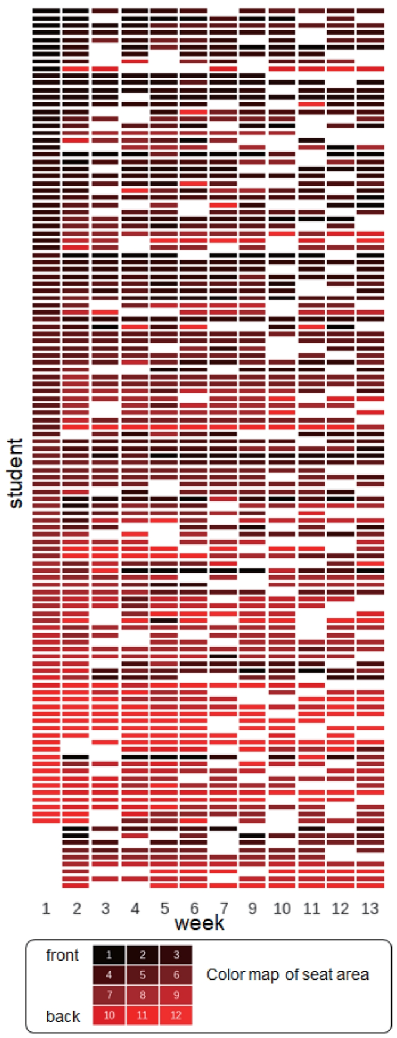

Figure 2: Area transition over 12 weeks. The 8th week and 14 week are removed because of examination weeks. The row corresponds to each student. From top to down, and from 1st week to 13 week, the seating area is sorted by the area number.

4. ANALYTICS RESULTS

4.1 Transition of Seating Area

We analyzed the seating areas by visualizing the transition over weeks. The classes were conducted 14 times, but we excluded the 8th and 14th weeks when students were taking examinations. To avoid sparse visualization, we collected data on students who attended more than eight of 12 weeks.

Fig. 2 is the visualized result of the transition in seating areas. The horizontal axis and vertical axis represent the i-th week and individual student, respectively. Therefore, a single row refers to a student's seating area transition(s). The color of each cell corresponds to the color map shown in the bottom part of Fig. 2. From the darker to brighter color, the seating area from #1 to #12 is represented. From the first column to the last column, the seating area is arranged in ascending order, corresponding to individual students.

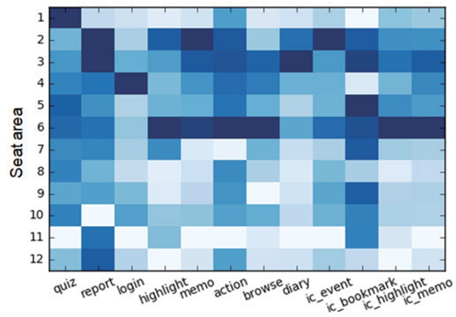

Figure 3: Distribution of learning activity scores. The horizontal axis is the item of activity score, and the vertical axis indicates the seating area. The darker color, the score is higher.

Table 3: t-test results. *: p<0.05, **: p<0.01

	front		back		
item	ave	std	ave	std	p
quiz	4.89	0.75	4.86	0.51	
report	2.93	0.88	2.95	0.81	
login	1.71	1.05	1.45	1.08	
highlight	0.46	0.94	0.13	0.34	*
memo	0.65	1.01	0.20	0.41	**
action	4.18	0.98	3.75	1.10	*
text	2.28	1.22	1.82	1.17	*
diary	1.02	1.26	0.43	0.57	**
ic_event	1.69	1.91	0.89	1.46	*
ic_bookmark	3.39	0.71	3.27	0.52	
ic_highlight	2.82	1.12	2.34	0.73	**
ic_memo	2.41	1.61	1.54	1.00	**
attend	8.98	3.53	7.69	3.24	*

Fig. 2 suggests that most students did not change seating areas often. They remained in the same area or one close by over several weeks. On the other hand, some students changed seating areas frequently (every week). Such students were more likely to be absent from classes. To investigate this subject quantitatively, we evaluated the variety of seating areas by comparing two student groups. In one group, members attended classes for nine or more weeks (123 students). In the other group, members attended classes for less than nine weeks but for at least three weeks (79 students). Note that we excluded students who attended class for less than three weeks to avoid meaningless calculations of seating area variations. For individual students in each group, we initially calculated the standard deviation (SD) of the seating area and then evaluated the average of SDs. The averages were 1.39 for the former group and 1.74 for the latter group, respectively. There was a significant difference ($p < 0.05$) between the two groups.

4.2 Front Area versus Back Area

We analyzed the respective scores for 12 types of learning activities: eight types of ALPs and four types of on-site class activities. Fig. 3 shows the seating area versus the item matrix (12 × 12 matrix) and represents the distribution of scores. The matrix element in blue corresponds to the score (the darker the color, the higher the score).

Overall, we can see that scores in the front areas (from #1 to #3) are higher than those in the back areas (from #10 to #12). This result suggests a hypothesis that students seated toward the front of the classroom participated in more activities than those in the back of the classroom. To investigate the hypothesis, we conducted a t-test for each item and assimilated the results as shown in table 3. Significant differences between groups were noted for nine of 12 items. Most differences originated from the activities related to e-book operations. Regardless of in-class/out-of-class activities, students seated toward the front of the classroom tended to engage in many activities accessible through the e-book system. Considering that the scores were based on the frequency of reviewing/previewing activities, we can summarize that students seated in the front of the classroom tended to perform these activities. In addition, these students utilized the e-book during class.

Regarding the remaining four items (i.e., quizzes, reports, login function, and ic_bookmark function), there was no significant difference between groups. Intuitively, people tend to think that students seated toward the front of a classroom get higher scores on quizzes; however, a significant difference was not identified in our experiments. The score of "report" indicated whether a student submitted his/her report, not the quality of the report itself. Therefore, most students earned similar scores. With regard to the login and ic_bookmark functions, there were fewer learning logs, which were not sufficient for performing statistical analyses.

5. CONCLUSION

In this study, we analyzed the relationship between learning activities and seating areas in classrooms. The learning activities were collected by the digital learning platform over 14 weeks and converted to scores, which indicated the amount of activities of the 12 items. Information regarding seating area was collected via a clicker plug-in on the Moodle system. We conducted t-tests to perform individual item analytics.

Overall, we found out that students with higher learning activity scores tended to sit toward the front of the classroom. From the seating area transition shown in Fig. 2, most students sat in the same area over weeks. This fact implicitly suggests that students who are highly motivated tend to select seats in the front of the classroom rather than in other areas. Furthermore, students' selections of seating areas did not change drastically over several weeks.

However, our current analysis has a limitation in that we could not investigate the motivations of students. Therefore, in our future work, we will analyze the relationship between the motivations and activities of students. Furthermore, the current strategy of collecting data regarding seating areas should be improved to grasp whether a student selects a seating area aggressively or passively. For example, a student who is late to class will be forced to select a seat near the front of the classroom because other areas are already fully occupied. To address the issue, we will ask students to select the seating area as soon as possible upon entering the classroom. A timestamp analysis would be helpful for grasping the situations of students.

In our future work, we will continue with the analytics of data collected in other classrooms and investigate whether the conclusions of this study can be applied generally to other classes and courses. Furthermore, we will introduce a new criterion such as self-efficacy[9] for the analytics involving seat selection and the motivation of students.

Acknowledgements

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